A REVIEW OF SHARP-SHINNED HAWK MIGRATION ALONG THE NORTHEASTERN COAST OF THE UNITED STATES

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LARGE numbers of Sharp-shinned Hawks (*Accipiter striatus*) on their autumn migration have been reported from several areas along the northeastern coast of the United States: Fishers Island, New York; New Haven, Connecticut; Cape May, New Jersey; Hooper Island, Maryland; and Cape Charles, Virginia.

Trowbridge (1895, 1902), Stone (1922), and Allen and Peterson (1936) hypothesized on the basis of their observations that: (1) Sharp-shinned Hawks normally migrate inland; (2) northwesterly winds drift ("lateral displacement" of Lack and Williamson, 1959) the hawks to the coast; and (3) once at the coast they continue along the coast. Later, while apparently supporting the wind drift hypothesis, Stone (1937) stated that hawks normally migrated along the coast. Rusling (1937) hypothesized that the northwesterly winds augmented the numbers normally migrating along the coast by drifting inland birds to the coast.

These papers are widely accepted as presenting evidence for the drift of diurnal migrants many miles off course by winds. I propose to show that the reported observations do not support this hypothesis, and I will present an alternative hypothesis that explains all of the observations.

REVIEW OF THE OBSERVATIONS

Fishers Island, New York.—The largest hawk counts [ca. 1,000–3,000 of all species on a very large flight (Ferguson, H. L., Jr., in litt.)] occurred on days of northwesterly winds (Ferguson and Ferguson, 1922), and were smaller than those farther to the west. The direction of movement was "invariably" southwest toward Long Island. The flights usually commenced early in the morning.

New Haven, Connecticut.—Trowbridge (1895, 1902) reported large numbers on days of northwesterly or northerly winds, and only stragglers on other days. A conservative estimate was 15,000 hawks in a day, of which "the sharp-shinned hawks outnumber the other species several times over" (Trowbridge, 1902: 738). The hawks flew westward along the shore of Long Island Sound.

Cape May, New Jersey.—The observations of hawk migration along the coast have been most frequent at Cape May, and they have been reported by Stone (1922, 1937) and Allen and Peterson (1936). Sharp-shinned Hawks were noted daily throughout the autumn, but the greatest numbers occurred on days of northwesterly winds. The migration commenced early in the morning, and if it

continued throughout the day the peak occurred during the morning. The striking observation was that on days of winds between northeast and northwest the birds flew low and northward along the Delaware Bay shore. However, on other days the hawks flew higher and across the bay toward Delaware.

Hooper Island, Maryland.—Hawks occurred in numbers on days of northwesterly winds, when they were seen flying northward (Rusling, 1937).

Cape Charles, Virginia.—During 1936 the largest counts of migrating Sharp-shinned Hawks along the northeastern coast were made at Cape Charles (Rusling. 1937). Hawks occurred daily, but the largest counts occurred on days of northeasterly winds. Contrary to the observations in other areas, few hawks were observed on days of northwesterly winds. On days of northerly or northeasterly winds the hawks flew northward, while on days of southerly winds the hawks regularly crossed Chesapeake Bay.

As I read the cited literature, several questions came to mind:

(1) Why is the number of Sharp-shinned Hawks relatively smaller at Fishers Island, and why are concentrations unreported along the coasts of Rhode Island and Massachusetts, when these areas are so much closer to the "normal inland route" than any of the other areas of concentration? Migration is intensively studied in this area (Bagg and Emery, 1960, 1961: Baird and Nisbet, 1959, 1960; Dennis and Whittles, 1955, 1956).

(2) On the other hand, why are numbers so great at Cape Charles, when this area is farthest from the "normal inland route"? All these hawks must pass through the narrow neck at the northern end of the peninsula (Rusling, 1937). This passage is unreported.

(3) Why are the largest numbers recorded at Cape Charles on days of northeasterly winds, and smallest on days of northwesterly winds?

(4) Why do the Sharp-shinned Hawks appear early in the morning along the coast with the peak before noon? If the origin of the hawks is 100–150 miles inland, and if the hawks are laterally drifted by the wind (oriented downwind drift is unreported for diurnal migrants over land when conditions are favorable for navigation and orientation), why is there not a time lag, with the hawks appearing several hours after sunrise?

(5) Why are the hawks not reported anywhere along the Atlantic coasts of New Jersey and the Delmarva peninsula except at the tips of the peninsulas? At New Haven hawks arriving from inland and striking the coast obliquely on days of northwesterly or northerly winds were seen flying along the coast in large numbers. However, no hawks were seen inland (Trowbridge, 1895). This indicates that the hawks arriving at the coast dropped to an altitude that made them more easily seen.

If hawks are arriving at the New Jersey coast from inland and striking the Atlantic coast obliquely, as shown on the map of Allen and Peterson (1936), is

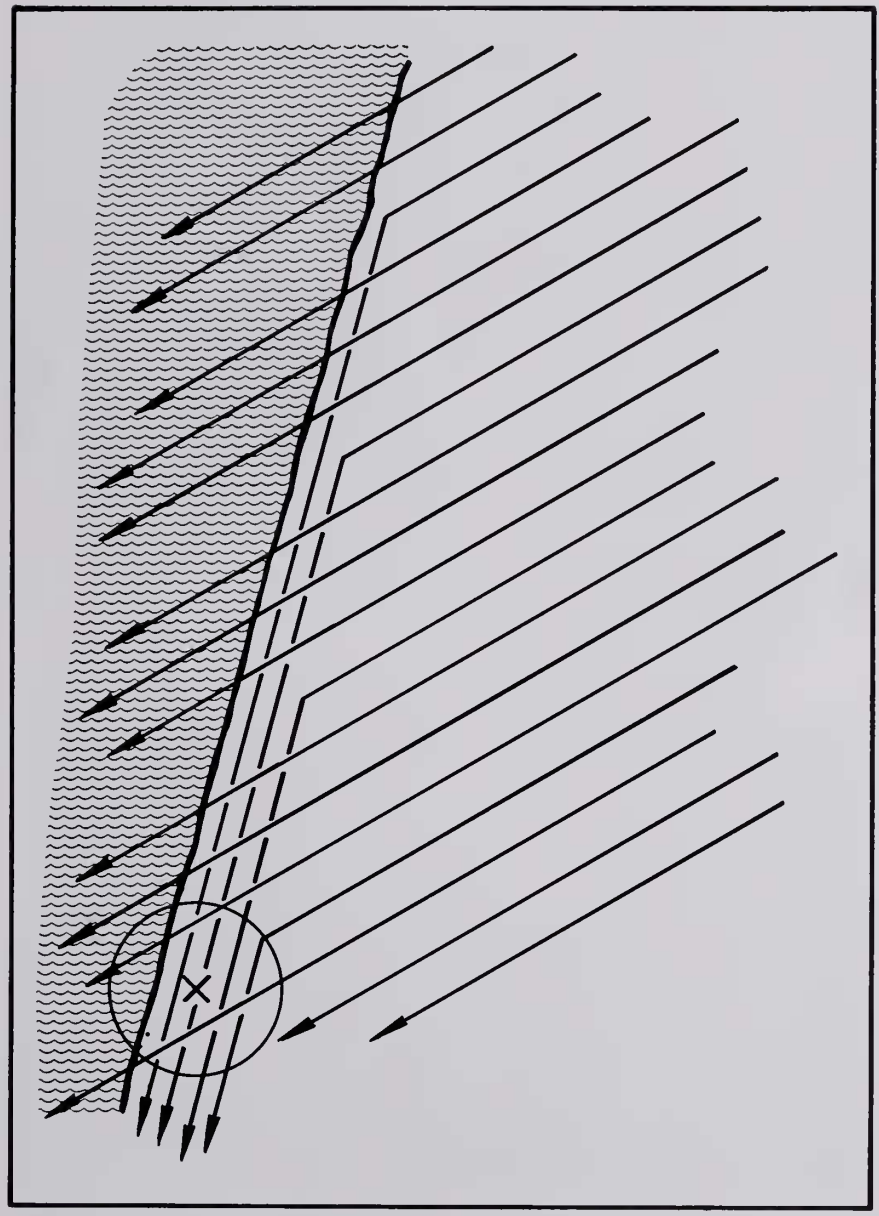

Fig. 1. Hypothetical example of the diversion-line phenomenon (after van Dobben, 1953). See text for explanation.

it not to be expected that the hawks should drop to a lower altitude (as they do at the Delaware Bay shore) and, thus, be seen flying along the coast?

(6) The only evidence presented in support of the wind drift hypothesis and of the inland migration route is the fluctuation in the *daily* counts *along the coast*, the largest numbers usually, but not always,[1] occurring on days of northwesterly winds. Recent visual and radar observations in Europe (reviewed by van Dobben, 1953, and Lack, 1959*a*, *b*) indicate that what the observer records from the ground may not be an index to the migratory movement, either quantitatively or qualitatively. That is, observed day-to-day fluctuations in numbers do not necessarily reflect the true fluctuations of the migration over the observation point, and the observed directions do not necessarily indicate the true direction of the bulk of the unobserved migrants. This lack of correlation between visually observed migration and true migration is a result of factors that bring the migrants into the observer's view, rather than those factors that stimulate the migration. Before we can understand the latter, we must be thoroughly familiar with the former (Swinebroad, 1960).

Individually these arguments against the wind drift hypothesis may not be insurmountable, but taken together they indicate that until further evidence is forthcoming the hypothesis of an inland migration route and drift by northwesterly winds of diurnal migrants is, at best, unproved.

THE DIVERSION-LINE PHENOMENON

When a broad-front, or even a narrow-front, migratory movement crosses a topographic feature or a border between two distinct habitats, a *portion* of the migrants changes course and flies along the topographic feature or habitat border (Fig. 1). This topographic feature or habitat border is called a guiding-line (van Dobben, 1953) or a diversion-line (Lack and Williamson, 1959). I agree with Thompson's (1960) statement that migrating birds on occasion fly along these topographic features, and that this is a "fact of observation—all else is theory." Thus, in theory, many factors may be involved in stimulating this behavior, the function of which is unknown. Some possible factors are: weather, wind direction, wind speed, topography, length of the water crossing, time of day, species of bird, altitude of bird, speed of the bird, age of the bird, previous experience of the bird, and length of time the bird has been flying. Few of these factors have been studied, but there seems to be a relationship between wind direction and the numbers of migrants counted flying along a diversion-line.

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[1] At Cape May between 16 September and 15 November 1935, the highest count was 1,057 on 15 October with a northwest wind, and the third high count was 591 on 1 October with a south wind (Allen and Peterson, 1936).

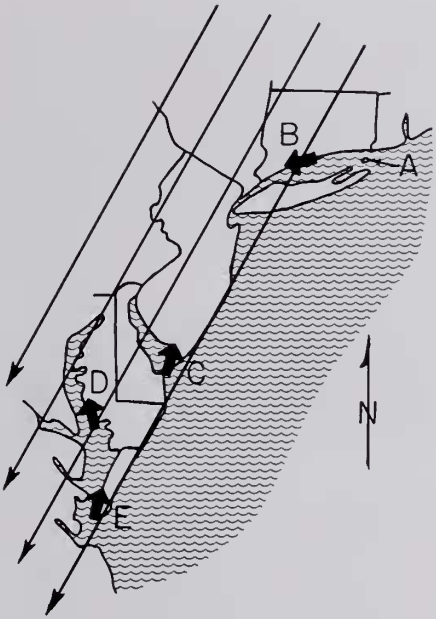

FIG. 2. Areas of reported diversion of Sharp-shinned Hawks along the coast of the northeastern United States, indicated by short thick arrows: New Haven, Connecticut (B); Cape May, New Jersey (C); Hooper Island, Maryland (D); and Cape Charles, Virginia (E). At Fishers Island (A) the hawks "invariably" continue southwestward toward Long Island. The long arrows, pointing southwest, indicate the general direction of the broad-front movement.

FIG. 3. The northeast–southwest line along the coast indicates the limit of the eastern flank of the *bulk* of the Sharp-shinned Hawk migration.

HYPOTHESIS

The published evidence supports the view that Sharp-shinned Hawk migration proceeds on a broad front in a generally southwestward direction (in the northeastern United States) at an altitude that makes observation difficult, and that the observed "concentrations" or "flights" are manifestations of the diversion-line phenomenon (Fig. 2). Thus, when the broad-front movement comes to the long water crossings of Long Island Sound, Delaware Bay, and Chesapeake Bay, a variable proportion of the migrants drops to a lower altitude and is diverted, depending upon the wind direction and other local factors.

This hypothesis can easily and reasonably answer the questions raised earlier in this paper.

Question (1).—The relatively small flights at Fishers Island and lack of flights in Rhode Island and Massachusetts may be due to differences in the breeding density to the northeast. If the line along the Virginia and New Jersey coasts

is extended northeastward (Fig. 3), the smaller breeding area to the east of the line, due to the presence of the Atlantic Ocean, is evident. The line passes through New Haven, the easternmost point of the larger concentrations.

Questions (2) and (3).—That the concentrations at Cape Charles were larger than at Cape May and that they occurred on days of northeasterly winds rather than northwesterly winds may be accounted for by the various local factors involved in stimulating diversion. Probably, when the winds are northwesterly many hawks do not reach the point, having diverted farther to the north in the vicinity of Hooper Island, a suggestion made by Rusling (1937).

Question (4).—If the migration proceeds on a broad front over the coastal plain, and if diurnal migrants start their migration early in the morning, the appearance of diurnal migrants in the morning is to be expected.

Question (5).—Hawks are not seen along the Atlantic coasts of New Jersey and the Delmarva peninsula, because they normally migrate at an altitude at which they are not easily detected.

Question (6).—From the evidence that migrating hawks occur daily along the coast, the best conclusion is that the eastern flank of the broad-front movement normally passes over the coastal plain. The evidence also supports the view that certain conditions are favorable for *observation* of the hawks.

DISCUSSION

I believe that the arguments expressed herein, although confined to the migration of the Sharp-shinned Hawk, are applicable to the migration of other diurnal migrants that occur regularly along the coast. I know of no unequivocal evidence that supports wind drift of any diurnal migrant.

This analysis points up the fact that a lack of appreciation for the unknowns that stimulate diversion may lead the observer to erroneous conclusions, as emphasized by van Dobben (1953) and Lack (1959*b*). For instance, Fig. 1 illustrates a broad-front movement crossing a diversion-line. The observer at x counts four birds flying along the coast for every two birds flying out to sea, when the actual ratio is 1 : 3. If the seaward movement is at a greater altitude than the coastal movement, as it usually is (van Dobben, 1953; Lack, 1959*a*, *b*), the likelihood of missing the seaward movement is increased, and the observer might erroneously conclude that the migration was entirely coastal. Further, if the factors are unfavorable for diversion, and if the seaward movement is high, the observer might conclude that no migration was occurring at all! That this is a real problem in interpreting visual observations is evident from the radar studied in England (Lack, 1959*b*). Ulfstrand (1960) presents a fuller theoretical treatment of this problem.

SUMMARY

The published evidence on the migration of the Sharp-shinned Hawk along the coast of the northeastern United States is reviewed and is shown not to support the hypothesis that the hawks (1) normally migrate inland, (2) are drifted to the coast by the wind, and (3) continue along the coast. An alternative hypothesis, which is supported by the evidence, is presented: the hawks normally migrate on a broad front in a generally southwestward direction over the northeastern United States at an altitude that makes observation difficult, and the observed "concentrations" or "flights" are manifestations of the diversion-line phenomenon.

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